THE RECORD

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. II. **1876.** **No. 5.**

U. S. NAVAL ACADEMY, ANNAPOLIS,

June 16, 1876.

Chief Engineer CHAS. H. BAKER in the Chair.

THE COMPARISON OF STEAMSHIPS.

BY PASSED ASSISTANT ENGINEER THOMAS W. RAE.

The paper here submitted to the Institute is substantially the same as a lecture delivered, a fortnight since, to the present graduating class of Cadet Midshipmen. Its object was to prepare them to judge intelligently of questions that at times agitate the Service to its depths, and again become dormant. Friendly critics considered the method of discussion to possess a certain interest, and that its more general publication might prove useful. In deference to these opinions it is offered almost as it was first written—the only changes being some new instances adduced and an effort to deprive it in some measure of its didactic character.

A great many statements pass for truth in the world because people have not the facts and figures at hand to disprove them. One may be perfectly satisfied of the fallacy of an assertion, but to bring to his views another who may be indifferent or opposed, he must argue step by step from sure grounds. The object of this discourse is to supply you with points relative to a subject which you will hear much discussed in your future career, and upon which you may be called to give a decision. I refer to ships-of-war, and their motive power.

The constructive Bureaux of the Navy undergo periodical attacks, whose recurrence is as well established as that of the seasons; and

while they last one is apt to be overwhelmed with chagrin at learning how far inferior to the navies of the world his own is, unless he chance to be in possession of definite data with which to test the mortifying asseverations thrust upon him. These crusades are sometimes initiated by private builders of ships and engines anxious for Government contracts, and at others by people within the Service for a variety of motives. Young officers are very prone to the affectation of decrying the *materiel* of their own navy and lauding that of others, without any very accurate knowedge of either. It is supposed to evince a mastery of naval science that is vouchsafed to few. An eminent officer of the Navy whose discrimination and broad views have become a proverb in the Service, declares it to be a notable fact that while foreign officers hold up the best phase of performance of their ships in discussing them—ours as persistently exhibit the worst aspect of our own as the criterion. What may be the cause of this difference of mental habit it is hard to say, but the justice of the stricture will doubtless be recognized by many. In comparing the navy of one country with that of another, it is necessary to understand the requirements of both, and this aspect of the case is too often overlooked. To illustrate by an extreme case: a nation without a seaboard would stultify itself in possessing any ships at all, while on the other hand an insular power with limited territory and large population must have the best or—perish. The swarming inhabitants need colonies to give them room; as well as importation of food from less crowded lands, and the commerce thus engendered as well as national integrity can only be maintained by a powerful navy. The unvarnished fact is that to a country which can easily feed its inhabitants a navy is a luxury, its only function being to protect the trade that importation of luxuries develops; since the foreign commerce that a fruitful and not over populous land maintains, clearly cannot be one of necessity. When therefore it is regretted that we have no large cruising iron-clads as other maritime powers have, it must first be considered whether armored batteries for harbor defence do not serve our need better. It is far from the purpose of these remarks to argue that our foreign interests are unimportant, or even that our cruising navy is commensurate with them. They are employed only to illustrate that a suitable naval armament for one nation might be preposterous for another of equal wealth and commercial strength, and also to point out what prescribes it when viewed as a strictly politico-economic question. Comparisons between navies taken *en-masse* are irrational. It is only permissible to consid-

er similar types of vessels in the different services and thus learn whether our own are better or worse.

The charges brought against the *materiel* of our Navy are numerous, the principal ones being as follows.

I. Excessive cost.
II. Expense of maintenance.
III. Lack of durability.
IV. Excessive bulk of Machinery.
V. Deficient speed.

They pertain more particularly to the machinery, but are in part applicable to hulls. In every comparison there must be a standard, actual or hypothetical, and in discussing the foregoing indictments that most commonly employed in each case will be designated. First comes the charge of excessive cost—this is preferred against navy-yard work as compared with that of private ship-yards and generally by interested parties. The accusation if true—which there is ample reason to doubt, where regard is had to the quality of the work—may be accounted for of late years, by the Government practice, of paying ten hours wages for eight hours work. While this custom exists, private yards will have a certain advantage, but whether they do actually profit by it or not, cannot be positively asserted without having at hand statistics and figures which it is nearly impossible to obtain. As a matter of opinion, I have no hesitation in stating that work similar, in thoroughness and nicety of finish, to that done in navy-yards cannot be turned out of private establishments at so little cost. It must not be forgotten that while the Government gives twenty five per cent. higher wages, it is absolved from the necessity of paying ground rent, taxes on expensive plant, tools, and raw material for which civil builders are liable, and these items in gross probably amount to enough to offset the higher wages.

Next comes cost of maintenance, and, before discussing this point, it is necessary to define strictly the term. It includes the cost of producing a certain amount of mechanical work as well as the expenditure of keeping the apparatus in repair and must therefore be considered in detail. The practice is to estimate the cost of work done in pounds of coal per H. P. developed. The work done in this case is always that performed in the cylinders, as this eliminates the influence of better or worse lines in the hulls of competing ships.

If the cost of the H. P. is estimated in pounds of combustible instead of coal, it eliminates the influence of better or worse fuel. The

amount of combustible is the difference in weight of fuel put into the furnace and the dry cinder and ash withdrawn from it. I have laid stress on the point of the refuse being dry, as it is the custom of stokers to drench it with water as it comes from the furnace, to escape the discomfort of heat and dust; and the weight of water absorbed by it would seriously affect the calculation. Three to three and one half lbs. per H. P. may be taken as the average performance of Navy vessels and better results are nowhere recorded. In the matter of repairs, men-of-war are contrasted with mail steamers and unfavorable inferences drawn in regard to the former. Here again a total lack of statistics baffles investigation, but much may be learned by a glance at the practice of both. Accidents to the engine proper are now a days of much more frequent occurrence in the mail service than with vessels of war—when no emergencies require excessive driving—and even during the war when the most unforeseen and exacting demands were made upon our machinery, the exhibit of casualties was no greater than in the mail service. With regard to the English Navy—the annual report of the Royal School of Naval Architecture, for 1871, reveals a status to which our Service affords no parallel.

After commenting upon a long list of cracked cylinders which includes those of the "Tenedos," "Black Prince," "Lord Clyde," "Hercules" and others—it uses the following expressions. "No one will deny the need of further improvement—no one at any rate, acquainted with the lengthy catalogue of cylinders broken year by year in Her Majesty's Navy—we cannot go on much longer without making some decided alteration in construction, for even cracking cylinders become monotonous after a time." Boilers seem to fail with us sooner and oftener for the reason, that disuse is more destructive than use, even with the most stringent regard to preservation. Mail steamers renew boilers about once in three years. We retain them four or five times as long, eking out their existence by repairs more or less extensive. Immediate economy is attained in this manner; but whether enhanced possibility of failure in an emergency does not neutralize the advantage, is an open question.

The Naval drill at Key West in 1874, revealed prominently the danger of this practice. Nearly all the ships possessed boilers whose lease of life had been supplemented by every device that ingenuity could uggest; and the routine of a three years cruise, while as favorable to their preservation as possible, had not made (and rarely makes) such pressing demand as would reveal unsuspected debility. When the

emergency arose and the strain was applied, they failed as must always be the case in similar circumstances. Mail steamers are put in thorough repair every trip. No sooner are they alongside the dock, than they are boarded by gangs of mechanics, who labor night and day as long as anything remains to be done. Our vessels have been know to stay at sea from six to nine months, perpetually under steam, and effectually maintaining a close blockade. This illustration shows clearly how little similarity there is in the exigencies of a civil and military marine.

Much has been claimed in the way of economic maintenance for the compound engines introduced of late years into the merchant service, but the absence of reliable data, makes it impossible to say whether or not they have done better than the same class of machinery, designed by the Bureau of Engineering. That this type possesses certain features favorable to economy is evident; it makes practicable a greater degree of expansion than the simple engine permits, and separates more thoroughly the boilers and condensers, greatly lessening the interaction of the fluids in each—with the difference of whose temperatures, efficiency varies: that is the hotter the cylinder and the colder the condenser, the greater the work done between them. But granting all this, their applicability to vessels of war is not finally settled. The lessened facility of manipulation largely affects other merits. The foregoing gives opportunity for certain corollary observations which must not be omitted. They are concerning the weight which should be ascribed to economy of maintenance as a quality of marine machinery.

Without advancing any positive views on the point, a few facts are submitted to illustrate how entirely different are the considerations which rule in various cases. To a merchant steamer, which makes prescribed voyages whose duration hardly varies a day, from year's end to year's end, economy is of prime importance. Every cubic foot of room saved from the space alloted to fuel, may be filled with freight which pays its way over and over again, instead of material whose carriage is an expense, in all senses, to the ship. And yet in the face of this, it may occasionally pay better to carry fuel instead of cargo, as in the case of steamers plying between New York and Rio Janeiro, which take out coal for the round trip of two months. Brazil having no coal must import it, and the cost is such as to make it cheaper for steamers to transport fuel for the home trip all the way from the United States to Brazil, rather than occupy its room with paying

freight. In the blockade-running days of the war, it was estimated that three successful trips were all it was advisable a vessel should make for the greatest profit, and they were built and run with this principle in view. Anything like judicious use or conservative precaution in regard to them was unknown. Our torpedo-boats employ the most wasteful propeller known to the profession, but its wonderful effectiveness in manœuvering, which is the chief desideratum in the vessels with which it is used, overshadows many and grave defects. Enough has been said to make it clear that in each class of vessel, some one of a number of desirable qualities has the greater weight and that it is rarely the same in different classes: you do not look for speed in an iron-clad floating battery, whose function is little more than harbor defense, nor for impregnability and heavy guns in a dispatch-boat; yet the criticasters, who periodically dispose of our Navy in the daily press, would have it appear that one vessel may include all these features. It may be fairly questioned then, if economy is the great desideratum of a man-of-war. She need never be compelled to make long runs at full speed, but may be often called upon to develop her maximum power at short notice and a moment's tardiness in this, may lose the chance to strike a telling blow upon an enemy, or leave her helpless in his power.

Sails spare a man-of-war the necessity of using fuel for extended periods and even the exigencies of a state of war do not affect this to any degree, for every campaign—if such a term may be applied to maritime warfare—is fought out on a definite plan from fixed strategic points and it does not require extraordinary fore-handedness to have ones' ships in the vicinity of these, ready to assume offensive operations. It will be small consolation at such a time to know that your machinery developes a H. P. for half a pound less coal than your adversary, if it do it so tardily that he has time to escape your attack, or you have not time to evade his. A ship may have shown unparalleled economy of maintenance for years, but if it cannot strike surely and heavily when the chance offers, or work out of danger with celerity when overmatched, it utterly fails of its purpose. There are times when a horse is literally worth a kingdom. Lack of durability is next charged, and at first glance not without cause. So much of this accusation as pertains to boilers, has been discussed under the previous heading, and the facts of the case elicited; let us now consider it with regard to hulls. During the war some two hundred and eight vessels were built by the Navy Department, of all possible classes—iron-clads for sea and inland

waters, general cruisers, light draught gun-boats, "double-enders" for river use, etc., etc. Of these, about fifty remain in service to-day. This seems a small per centum but, besides the casualties of war, which were large, it must be remembered that with the advent of peace, the occupation for craft designed for inland waters ceased and they were gotten rid of as quickly as possible. Storing *material* for such a contingency as a civil war would have seemed insanity twenty years ago, and the quantity of seasoned ship timber in the docks, when it burst upon the country, was not a moiety of what was needed to create a navy. It takes from two to eight years to properly season live oak, and as such delay was not to be thought of, constructors took what they could get. I quote from the Honorable Secretary's report for 1862 which describes the situation very graphically.

"The war found us literally destitute of material in our navy yards as well as with but few ships to sustain the national integrity. From mistaken economy, or from design, the government was, in its need, deficient in ships and destitute of material for their construction. No alternative was left, when resistance was made, but for the Department to build its vessels as speedily as possible and of such timber as could in the great haste and emergency be procured. As a consequence, vessels that should have lasted for years will soon perish and must in the mean time involve heavy expense for necessary repairs in order to keep them afloat."

With the proper material no better hulls are built, than our own; and the concluding words of the Honorable Secretary might have been adduced to explain the facts that gave rise to the charge against naval vessels of excessive cost of maintenance, discussed under the previous heading.

Excessive bulk of machinery is a favorite reproach and contrasts are drawn between naval and merchant steamers, to the disadvantage of the former. You will hear it said in such comparisons, "Such an engine develops so many H. P. and occupies only so many feet of the length of the ship—in a Navy ship it would have taken half as many more." This sounds like a grave accusation until it is considered that, for safety from shot, naval machinery is kept entirely below the water line, while in merchant vessels there is no limit vertically to the room which the machinery may occupy. The real criterion is the cubic feet of space occupied per H. P. developed, and, measured in this manner, our vessels are second to none in economy of space. In ships of pre-

cisely similar lines, the fraction of length devoted to machinery is a fair measure of comparison, when the necessary passages about the engines, the boilers and coal bunkers are considered; and this suggests a caution which must be heeded in applying this gauge. Let it be clearly understood what is comprised in the question. An example will illustrate the importance of this. Suppose you were comparing a certain machine, using anthracite, with another driven by bituminous coal. Both fuels weigh about alike, per unit of volume and their evaporative efficiencies are very nearly equal. It would then seem that they might be dismissed from the question. But bituminous burns about two and one half times as fast as anthracite coal, and the comparison hinges upon this fact. For example, a boiler burning bituminous coal can develop the same power in the same time as an anthracite burning boiler with a grate of two and one half times larger area, and consequently may reduce its boilers in the proportion of two to five as compared with the latter. This point would give the engine driven by bituminous coal vastly the advantage in economy of space if the investigation had stopped here, but it has to be pursued farther.

Although space occupied by machinery proper has been economized by the adoption of quick burning soft-coal, it is clear that the room saved must be devoted to the bunker, if the ship is to carry fuel for the same number of days steaming; and the consideration of this point is next in order. Our vessels carry enough for full steaming from ten to fifteen days, and twelve may be assumed as the average. We have one class built solely for speed. I refer to that specified in the Navy Register as the "Connecticut class," which carries fuel for barely six days; but as this means a consumption of 135 tons per diem, and an average speed of 16.95 knots, the showing is by no means bad. If you apply the law of speeds varying as cubes of power developed—or, what is the same thing, coal burned—you will find that ships of this class carry fuel enough to drive them 5,000 miles at the rate of 11.25 knots, which will accomplish about every voyage possible on this planet. English vessels, and in fact all that employ bituminous coal, do not carry more than four days' fuel, and this must be remembered in contrasting them with ours.

It is then permissible only to compare engines with engines, and by this I mean apart from boilers and all appendages. If the contrast is to be carried farther it must include boilers and bunkers carrying the same number of days' consumption of fuel. The space occupied by propeller shafting may be excluded in calculating room occupied by

engines, as various circumstances influence the proximity or remoteness of the engine, from the propeller, which do not result from the design of the machinery. Although definite data for this comparison are difficult if not impossible to obtain, something may be arrived at by inspection of the drawings, published by Scott Russell, of the fastest specimens of English-built steamers, viz. the Dublin and Holyhead Mail Packets. These maintain 14.5 knots per hour, for four hours. The space occupied by machinery relatively to H. P. developed, shows clearly that our designers have nothing to learn from such models. Recurring to foregoing remarks on the importance of economy of maintenance in men-of-war, it will be seen that the use of a fuel which burns two and one half times as quickly as others, is a long stride in the direction of obtaining ships which can develop their maximum power in the least time. The dense smoke of this fuel is, however, an objection to its use, as revealing a ship's position in blockade, and enhancing the obscurity involving an action at sea. The last, and a very serious charge against our Navy, is deficient speed. This has almost come to be accepted as a fact; but with what justice let us inquire. The fair way is to take our Navy list and contrast each class of ships in it with similar vessels in some other navy, and see how we bear the test. We

TABLE I.

I.		II.		III.		IV.		V.		VI.	
4450–3980	S	3250–2700	S	2400	S	2220–2100	S	1900–1550	S	900	S
Connecticut		Lancaster		Alaska	12.0	Lackawanna	12.00	Juniata	11.00	Kansas	10.00
Florida	16.98	Brooklyn	9.19	Benicia	12.00	Ticonderoga	12.00	Oneipee	11.00	Nipsic	12.00
Iowa	16.98	Pensacola	10.00	Omaha	12.00	Canandaigua	12.00	Quinnebaug		Saco	
Tennessee	12.73	Hartford	9.50	Plymouth	12.00	Monongahela	12.00	Swatara	11.00	Nyack	12.00
Antietam		Richmond	9.50			Shenandoah	12.00	Galena		Shawmut	12.00
Delaware	11.00	Congress	13.00					Vandalia		Yantic	9.75
Java		Severn	13.00					Marion	12.00		
New York		Worcester	13.00					Iroquois	11.70	Average speed 11.15 knots.	
Pennsylvania		Trenton						Kearsarge	11.70		
Susquehanna	11.00							Adams			
								Enterprize			
Average speed 13.73 knots.		Average speed 10.84 knots.		Average speed 12 knots.		Average speed 12 knots.		Essex			
								Alliance			
								Alert	10.00		
								Huron			
								Hanger	11.20		
								Wachusetts			
								Mohican	11.2		
								Tuscarora	11.2		
								Wyoming			
								Avge speed 11.30 knots			

will neglect auxiliary steam-powered ships, such as the Colorado and class, and paddle-wheel steamers, like the Powhatan, because they are of an obsolete type.

Dispatch-boats and screw-tenders are also excluded, and although we have nine double-turretted iron-clads, of an average tonnage of 1,750 and fifteen single-turreted, with an average tonnage of 610, the speed of all of which ranges from 5 to 10 knots, we must ignore them, as there is nothing in other navies with which they may properly be compared. Inspection of the Register will then show that there remain six classes of ships, (*see Table I,*) for which we may find counterparts in other navies—for example the English. They are as follows.

CLASS I.

CONNECTICUT AND CLASS.—Disp. 4,450—3,980 tons.
Speed 16.95—11 knots—av. 13.73.

CLASS II.

LANCASTER AND CLASS.—Disp. 3,250—2,700 tons.
Speed 13—9.19 knots.—av. 10.84.

CLASS III.

ALASKA AND CLASS.—Disp. 2,400 tons.—Speed 12 knots.

CLASS IV.

LACKAWANNA AND CLASS.—Disp. 2,220—2,100 tons.—Speed 12 knots.

CLASS V.

JUNIATA AND CLASS.—Disp. 1,900—1,550.
Speed 12—10 knots—av .11.30.

CLASS VI.

KANSAS AND CLASS.—Disp. 900 tons.
Speed 12—9.75 knots—av. 11.15.

Taking from the Royal Navy list of 1876, groups of ships, (*see Table II,*) of the same average displacement of each of our six classes, as enumerated in Table I, we have, to correspond with our first class, twelve ships whose average speed over the measured mile is 11.5 knots. To obtain a sufficient number for a just comparison, it was necessary to exceed the limits of displacement of our first class, viz. 4,450—3,980 tons, and the twelve examples quoted fall outside of them some two per cent. each way. For the second class, it was hardly possible to obtain a counterpart in the English Navy. Even by reducing the number to seven, the displacement ranged from ten per cent. below to two per cent. above our limits, viz. 3,250 tons—2,700 tons. The average

speed over the measured mile of this batch is 10.77 knots. The third class is somewhat nearer ours. It comprises six ships whose displacement exceeds our standard, 2,400 tons, some four per cent. each way. Its average speed over the measured mile, is 16.57 knots. The fourth class though numbering but seven ships, falls within our limits, viz. 2,220—2,100. The average speed of this group over the measured mile is 10.66 knots.

The fifth class numbers twelve and falls entirely within our limits, viz. 1,900—1,550 and the average speed, over its measured mile, is 12.47 knots. The sixth class also conforms to our standard, viz. 900 tons, and numbers eight. The average speed over the measured mile is 9.42 knots. Tabulating the foregoing compilations, the showing is as follows.

TABLE II.

I. 4450–3980		II. 3250–2700		III. 2400		IV. 2220–2100		V. 1900–1550		VI. 900	
	S		S		S		S		S		S
Alnoukir	9.55	Aurora	10.20	Barrosa	11.51	Cadmus	10.97	Blanche	13.63	Myrmidon	10.05
Ariadne	13.06	Endymion	11.25	Jason	12.04	Charybdis	10.08	Danae	12.58	Nassau	10.58
Bristol	10.54	Forte	11.48	Raccoon	10.31	Juno	10.53	Daphne	12.47	Petrel	8.98
Galatea	11.79	Narcissus	10.59	Rattlesnake	12.17	Pearl	11.05	Dido	13.29	Rapid	8.80
Himalaya	12.92	Pembroke	7.60	Wolverine	11.25	Satellite	10.26	Druid	13.06	Rosario	8.31
Liffey	12.16	Simoom	11.58	Challenger	9.66	Scout	10.87	Dryad	11.96	Sheerwater	8.05
New Castle	13.28	Urgent	12.71			Scylla	10.83	Eclipse	13.02	Star	9.50
Nile	8.20							Fox	9.31	Sylvia	10.24
Rodney	11.47						10.66	Nymphe	13.06		
St. George	10.93						.90	Sirius	13.10		
Topaz	11.12						9.59	Spartan	11.14		
Undaunted	12.92							Vestal	12.81		
Average knots	11.6	Average knots	10.77	Average knots	11.57	Average knots.		Average knots.	12.47	Average knots.	9.42
	.90		.90		.90				.90		.90
	10.35		9.70		10.41				11.22		8.47

Our Ships.		English.
13.73	Ist CLASS.	11.50
10.84	IId CLASS.	10.77
12.	IIId CLASS.	11.57
12.	IVth CLASS.	10.66
11.30	Vth CLASS.	12.47
11.15	VIth CLASS.	9.42

Our Ist class is notably ahead.
Our IInd " is about on a par.
Our IIIrd " slightly better.
Our IVth " decidedly superior.
Our Vth " as much worse as the preceding class is better.
Our VIth " markedly better.

In justice to our Vth class it must be said that it includes many yet untried ships, whose speed will no doubt considerably increase the average. Among these may be cited the "Quinnebaug," "Galena" and others whose probable speed is twelve knots. It should be remarked moreover that the scanty record of our ships is not only due to the fact that many have not yet undergone trial—as in the Ist and Vth classes—but also to the practice of running upon half, or some fractional power, on ordinary occasions. To obtain the speed at sea, under full power, from log-books, can only be done by applying the law of speeds varying as cubes of powers, and is so tedious as to be practically impossible. The introduction of the English test over the measured mile would greatly facilitate comparisons of this nature. English ships of this class have engines of some fifty per cent. greater horse-power than ours.

This exhibit must again be modified for the following reasons. The speeds given are for a measured mile in the case of the English ships, and in ours for the average performance at sea, for periods of not less than twelve hours; and the two are vastly different. The former means the speed from five to seven minutes in smooth water, and without touching a fire, or feeding or blowing down the boilers. The conditions are the most favorable possible. Speed at sea means that, for hours and days in rough water, and with the firing and feeding and blowing down of boilers necessitated by the longer period of trial. A board, of which Rear Admiral Goldsborough was President in 1868, thus mentions that of the "Wampanoag" in a report which, while condemning her for general cruising purposes, recognizes her complete fulfilment of the object for which she was designed.

"She, as her log shows, did go on an average, for 24 consecutive hours, 16.95 knots, her maximum speed during the period being 17¼ knots." The wind was fair throughout with a force from three to four. It could scarcely have been of any service upon the occasion and no canvas was used.

The log of the trial characterizes the sea as "rough," and the wind "a strong breeze."

Long and careful averaging of log-books has made it possible to deduce a ratio between performance over the measured mile and at sea, and the latter is variously given as eighty-five and ninety per cent. of the former, Captain Gore Jones R. N., Naval Attaché of the British Legation at Washington, puts it at ninety per cent. and Mr. Reed the late Chief Constructor of the Royal Navy publishes it at eighty-five per cent. Although the latter, has probably wider and better opportunities of judging, as it is to him that all returns and statistics of this nature naturally come, we will adopt the larger coëfficient, and apply it to the comparison already made. It modifies it as follows.

Our Ships.		English.
13.73	Ist CLASS.	10.35
10.84	IId CLASS.	9.70
12.	IIId CLASS.	10.41
12.	IVth CLASS.	9.59
11.30	Vth CLASS.	11.22
11.15	VIth CLASS.	8.47

In this exhibit we take the lead in all classes. Bear in mind that these results are averages, and that in every class there is little doubt but that the best English ship would badly beat our worst; but no sound logician argues generally from isolated cases, and the conclusion is unavoidable that our vessels are as fast as any built.

The object of this discourse has been to put you in possession of means wherewith to meet the attacks upon the *materiel* of our Navy, which are daily put forth, in and out of the Service, by loose-tongued and irresponsible people. All that is needed to discomfit such indiscreet folk are facts and figures. It is impossible to controvert an assertion advanced with an air of authority, unless one has at hand statistics, and because these are so difficult to obtain, the reckless statements made concerning our ships as compared with those of other nations, have so long passed unchallenged. If in addition to furnishing you with means of vindicating our naval architecture from the aspersions cast upon it by heedless detractors and calculating malcontents, I have made clearer to you the importance of never hazarding an opinion upon any subject from insufficient data, the imprudence and presumption of endorsing every cleverly expressed assertion, without holding it up in every possible light, and applying to it every available test, these words will not have missed their mark. There are

plenty of opinions current which are built on no better foundation than some epigrammatic phrase which one speaks "trippingly on the tongue,"—a mere argument to the ear, which nevertheless to inconsiderate minds has all the ring of true coin. There is as much worldly as spiritual wisdom in the injunction

"Prove all things."

COMMANDER FARQUHAR inquired how the maximum and minimum speeds, as set forth in the comparison, had been obtained.

P. ASSIST. ENGINEER RAE replied, that they had been obtained partly from personal observation, and partly from the statements of officers who had been either in command of or attached to the different vessels that had been spoken of.

LIEUT. R. P. RODGERS stated that in his opinion the lecturer had certainly over-estimated the speed of that class of vessels to which the "*Plymouth*" belongs. While he was attached to her the best she ever did, under the most favorable circumstances, was eleven knots.

LIEUT. MASON agreed with the gentlemen who had just spoken. He was attached for some time to the "*Omaha*." Her maximum speed was nine knots. He was on the "*Benicia*," on one occasion, when she made eleven knots, running from San Francisco to Mare Island, in California. The tide however was in her favor. He believed the speed of the above mentioned class of vessels to be rather below the presented estimate of Mr. Rae.

P. ASSIST. ENGINEER RAE replied that not having the log-books of the different ships at hand, he of course could not substantiate and verify the given speeds of the different classes of ships. In some cases, where he was present himself, he could vouch for the accuracy of the figures; in a great many cases, however, he had simply derived his information from officers in command.

P. ASSIST. ENGINEER JONES stated that the "*Contoocook*" of the class under discussion, made on her trial trip, thirteen knots.

P. ASSIST. ENGINEER RAE remarked that he remembered that circumstance very well himself. The "*Alaska*" also developed a good speed.

COMMODORE PARKER inquired whether the speed thus obtained was taken for one, twelve or twenty hours.

P. ASSIST. ENGINEER RAE replied that it was taken for from six to twenty-four hours. The "*Lancaster*", he stated, had made twelve knots for hours without any difficulty.

LIEUT. SPERRY stated that although some of the vessels mentioned might have failed to come up to their standard on different occasions, others had gone beyond it. The "*Kearsarge*", he stated, made a run of five hundred and fifty miles in fifty hours, an average of ten and a half knots, with one of her fires banked. She could make more than ten knots without sail.

COMMODORE PARKER moved that the thanks of the Institute, be tendered to P. ASSIST. ENGINEER RAE, for his valuable and interesting paper.

CHIEF ENGINEER BAKER stated that before putting the motion, he had some brief remarks to make on the subject under discussion, and would claim the indulgence of the members for a few minutes. It should be borne in mind, that in making comparisons of speed between British and American men-of-war, the circumstances under which their trial trips take place ought certainly to be taken into consideration. On the one hand, a corps of thoroughly trained officers, especially employed for such purposes, is placed on board an English man-of-war on her trial trip. A full crew of firemen, coal heavers &c, are furnished. The best of coal is picked out for the occasion. Even the wind, tide and condition of the water, are taken advantage of. On the other hand, in a great many cases, our vessels on their trial trips are short of officers, firemen, &c. The coal cannot be compared to that used by the English on such occasions. These facts, well known, and easy to be established, certainly should cover up any little discrepancies that may exist in favor of the English."

The thanks of the Institute, were then tendered to P. ASSIST. ENGINEER RAE.

* At the time of submitting the paper to the Institute, the speed of United States vessels of war, in Table I, had been compiled from personal observation and that of officers accessible to the writer—as transpired in the discussion which followed the reading. Since then the table has been reconstructed in accordance with official Logs in the Navy Department, and no speed entered that was not maintained, under steam alone, for at least twelve hours. This recourse has confirmed, to an unexpected degree, the position originally taken.